

CERTIFICATION

I, Samuel D. Larson, declare that I am well acquainted with the English and German languages and that, to the best of my knowledge, ability and belief, the attached translation of the German language application DP 1854 WO is a true and faithful translation of that document.

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Signed: Samuel D. Larson

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Diehl Munitionssysteme GmbH & Co. KG, 90552 Röthenbach
and
Junghans Feinwerktechnik GmbH & Co. KG

Programmable artillery fuse

The present invention relates to a programmable artillery fuse according to the preamble of Claim 1.

Such a fuse having a coupling coil, positioned coaxially in the region of its tip, for accepting fuse-setting data during the loading procedure at the howitzer is NATO standard and described in greater detail, for example, in DE-Z SOLDAT & TECHNIK [SOLDIER & TECHNOLOGY], Issue 3, 1997, for the fuse series ANNZ DM74 and ZDZ DM52. This standardized conductive interface operates at a frequency of 100 kHz and programming cycles of 775 ms, a maximum of 30 bits able to be transmitted and acknowledged within a cycle. Such a data rate is completely sufficient for the input of typical fuse-setting information, particularly target distance and triggering proximity, which are dependent on the flight time, or impact delay and/or detonation height and possibly overflight safety and self-destruct criteria.

According to EP 0 451 522 A1, a transmitting coil system is housed in the howitzer, for the inductive transmission of fuse-setting information into a fuse-setting coil of an

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artillery shell positioned coaxially in the fuse tip, which extends essentially over a third of a circle, along which the projectile is supplied to the breech of the weapon and its fuse is inductively set at the same time, i.e., equipped with the trigger information.

According to U.S. 4,788,899 A, in contrast, fuse-setting information of lesser informational extent, as may be represented using 8 bit digital information, for example, is stored in a capacitor bit by bit in that the capacitor is charged in the fuse tip via a photocell, which has light applied to it from the fuse front face via an optical fiber parallel to the fuse axis. To input the fuse-setting information, i.e., to charge individual capacitors, a hood is temporarily placed on the fuse front face which contains a light source that irradiates these locally assigned optical fibers to their photocells via individually releasable channels. The informational extent thus transmittable is therefore significantly less than in the case of inductive fuse setting via a programming coil contained in the fuse, and may not be integrated into the howitzer as free of complications as inductive information transmission in the course of the loading procedure.

It is provided in U.S. 4,091,734 A, and comparably thereto in EP 0 806 625 A2, not for setting artillery fuses, but rather for cable-free information transmission to air-launched rockets from their carrier aircraft, that the rockets are each equipped with at least one optical-electronic receiver for optical-electronic information transmission in order to avoid departure malfunctions as may occur when, upon delivery of the rockets from this

flying launcher, plugs must first still be pulled out of the rocket hull from cable connections transverse to the start direction.

For future generations of artillery ammunition, to reduce the ammunition required as a result of increased hit precision, the use of target-dependent satellite-supported path influencing is provided in particular. The artillery ammunition may be equipped, according to U.S. 5,467,940 A, with Canard rudders to increase the range by entering a flat glide flight after the apogee of the ballistic starting curve, or may be equipped, according to DE 197 40 888 A1, with a braking parachute to steepen the descent rate out of the ballistic start curve, for example. In the latter case, it is suggested therein that the target position for a final phase control of the projectile be transmitted to the shell using an inductive data transmission system before the shell is fired, for example, and then this predetermined target data be compared after firing on board the artillery projectile with satellite navigation data obtained there, in order to obtain correction data for the projectile steering. Such target coordinates, which are merely to be preset, only have a data extent in the magnitude of the typical fuse-setting information, however, possible current projection data for accelerating the use of satellite navigation may not be reliably introduced into the ammunition via an inductive system of this type in the course of the loading procedure with the speed necessary in regard to the cadence of the howitzer and then possibly queried again to verify correct data transmission.

This also applies correspondingly for the use of correction fuses to increase the hit precision by reducing the lengthwise scattering of artillery ammunition. With these fuses, upon reaching a predetermined path point, the artillery projectile is deflected into a steeper descent path by an aerodynamic braking device integrated into its fuse, as described in greater detail in regard to the apparatus in DE 100 23 345 A and functionally in DE 199 57 363 A. DE 198 24 288 A1 represents a further example of a correction fuse of this type, in which a GPS antenna is located in front on the fuse tip, behind which electronics for performing the satellite navigation functions are positioned inside. Foldable mantel segments for the braking function of the correction unit are positioned in the largest lower diameter region of the projectile fuse between the electronics and the fuse safety device. Established artillery ammunition, which is first equipped with its fuse in case of use, is now fired using such a braking fuse instead of the typical time fuse if necessary. The function-critical braking point on the ballistic flight path then actually flown is expediently established by comparing the current path data with predetermined path criteria, the information about the current flight path being obtained on board the projectile using satellite navigation.

Such a satellite-supported path determination is, however, extremely time-consuming in consideration of the short computing time available during the engagement possibilities in the course of a flight, such as braking the projectile at the right time, since multiple navigation satellites must be detected over the horizon and analyzed

in regard to their instantaneous path data. This computer navigation task for the current determination of sequential positions on the path flown may, however, be decisively shortened if as much projection data as possible about the location determination using the navigation satellites foreseeably to be detected may also be given to the navigation computer on board the projectile. In order to be current, this data may not be provided already in the magazine, but rather it must occur close in time to the firing of the ammunition in order to be able to actually noticeably shorten the necessary computing time for the path determination on board. However, the data rate necessary for transmitting navigation information for multiple satellites in a short time is much too high to be executed via the inductive coupling coil of the loading system.

Integrating a second coil system into the fuse, which is optimized for the higher data rate for additional information to be input inductively in addition to the typical fuse-setting presets, could be considered. However, the installation space under the fuse ogive is insufficient for two inductive coupling systems to be operated separately; this does not even consider the problems of interference-free separate operation of two systems which are inductively coupled because of the installation conditions. The suggestion of implementing the higher data rate of the additional information via a sensor in the ammunition tail, known from EP 0 992 762 B1, also does not represent an achievable solution, at least for existing ammunition. This is because a reliable, rapid information connection to the electronic assembly in the

ammunition tip through the warhead is necessary for this purpose, which may not be implemented as retrofitting in existing ammunition, but rather requires a new construction. Such information coupling into the projectile floor in the course of supplying the ammunition would also not be compatible with the fuse setting introduced during the loading procedure. Because of such compatibility requirements, the typical inductive fuse-setting capability must be maintained without interference in any case.

In recognition of these conditions, the present invention is based on the technical object of being able to implement data rates which significantly exceed the data extent of current fuse-setting systems directly before the firing of the ammunition from the howitzer, particularly to be able to transmit the greatest possible extent of initialization data for a rapid satellite-supported flight path determination on board the projectile, without interfering with the established inductive fuse setting in the course of the loading procedure in this way.

This object is achieved according to the present invention by the combination of essential features cited in the main claim. According to this claim, an infrared data interface in the form of at least one IR receiver, which is connected to the navigation electronics with its satellite navigation receiver and a satellite antenna, as is described in greater detail in DE 10037886 A, for example, is positioned under the radome of the fuse tip, e.g., in front of the programming coil for the inductive fuse-setting standard also positioned coaxially therein (possibly behind a

protective cap made of infrared-transparent plastic material).

The present invention and its refinements are described in greater detail in the following on the basis of the single figure of the drawing, which has a simplified axial frontal view toward the fuse tip, shaped like a truncated cone, as its object.

At least one infrared data interface 13a and/or 13b is located inside the tip 11 of the fuse 12, which essentially has the shape of a hollow truncated cone and may be blown open laterally to release braking means. This interface is essentially a commercially available infrared receiving diode, known per se, which is installed coaxially behind the flattened fuse tip 14 and via which a data stream up to 10,000 bits may be implemented without anything further, which is completely sufficient to transmit all available initialization information for satellite navigation into the ammunition parallel in time to the inductive fuse-setting procedure in the course of the loading procedure and thus reduce the computing outlay on board to a minimum.

In this way, by maintaining the fuse-setting coil in the fuse 12, the function of the widely established, standardized inductive fuse-setting procedure in the course of the loading procedure in the howitzer is ensured, while a preferably pulse-frequency-modulated transmission of initialization information for the satellite navigation is performed simultaneously via the additional infrared data interface 13a placed in front, just behind the fuse tip 14. These two data paths may therefore not mutually impair one

another in spite of being close spatial neighbors because of the different transmission principles (inductive and optical).

If the infrared data interface 13a is positioned coaxially behind the center of the small truncated cone base of the fuse tip 14 in the form of a receiving diode, which is sensitive to infrared radiation, as shown, for the optronic transmission of the initialization information in the course of the loading procedure, this requires a relative approach of the fuse tip 14 to a thrust bearing in the weapon, equipped with an infrared radiation transmitter as a coupling element, in order to be able to transmit the initialization information in the course of the loading procedure. Because, in the established loading technology, the ammunition is not axially displaced before reaching the breech, this thrust bearing having its infrared coupling element must be axially displaceable in order to be able to approach the data interface 13a sufficiently closely for the optronic data transmission in the course of the loading procedure, even if there is shorter ammunition, which would nonetheless still require significant interventions in the construction of the weapon.

This problem is overcome if, according to a refinement of the present invention, as also shown in the drawing, a ring 15 is provided as the thrust bearing for receiving the coupling element of the infrared transmission path, whose internal diameter is between the smallest and the largest diameters of the fuse 12, which is shaped like a truncated cone, so that it may be pushed onto the fuse 12 from the flattened tip 14 in a self-centering way without problems.

The infrared data interface 13b is then accessible not in the flattened tip 14, but rather in the truncated cone lateral surface of the cap 11 for supplying modulated IR radiation, for which the ring 15 is equipped with at least one emitting coupling element 16 as shown in the drawing. In order to not have to define the positioning of the ring 15 in relation to the interface 13b with a narrow tolerance, multiple transmission paths operated in parallel are made possible distributed around the circumference of the ring 15. If large aperture angles are provided for the interface 13b and the coupling element 16, it is sufficient, because of the small installation space there in the fuse 12 itself, to provide only one data interface 13b, while at least three coupling elements 16 are distributed uniformly around the ring 15.

The typical inductive fuse setting is not suitable for acknowledgments to check the total extent of transmission, at least for acknowledgments of a check sum, because of its data processing capacity in regard to the transmission speed. In contrast, the rapid infrared transmission allows a complete acknowledgment of the data sets supplied for the functionally important initialization information for satellite navigation, for which both the interface 13b and the coupling element 16 are each laid out as transceiver units.

Therefore, in a modern artillery fuse 12, particularly having a braking fuse function, to be able to supply a significantly larger data quantity than the fuse-setting information to be transmitted inductively in the course of the loading procedure of the howitzer for firing ammunition

equipped with such fuses 12, particularly to supply initialization information for satellite navigation on board the ammunition during its ballistic flight, the fuse 12 is equipped according to the present invention, behind its flattened radome tip 14, for example, with an infrared data interface 13 in the form of a receiving diode sensitive to infrared radiation, for example, via which the initialization information for the satellite navigation receiver may be supplied optronically parallel in time to the inductive fuse-setting information, but without impairing it. Preferably, however, a transceiver interface 13b is installed in the cone mantel region of the fuse cap 11, which works together with at least one of multiple transceiver coupling elements 16 on a ring 15, operated bidirectionally in parallel, through which the fuse tip 14 projects for the data transmission.

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